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Madison

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[54] **ROAD AND RAIL VEHICLE USING RAIL WHEEL DRIVE AND APPARATUS**

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[73] Assignee: **Harsco Technologies Corporation**, Fairmont, Minn.

[21] Appl. No.: **820,897**

[22] Filed: **Mar. 19, 1997**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 505,025, Jul. 21, 1995, Pat. No. 5,619,931.

[51] **Int. Cl.**[6] **B61D 15/00**

[52] **U.S. Cl.** **105/72.2**

[58] **Field of Search** 105/72.2, 215.1, 105/215.2, 453

[56] **References Cited**

U.S. PATENT DOCUMENTS

1,827,898	10/1931	Moore .	
2,157,651	5/1939	Fildes .	
2,896,553	7/1959	Whisler .	
3,019,742	2/1962	Kershaw .	
3,134,343	5/1964	Matsumura	105/72.2
3,179,066	4/1965	Koshobu	105/72.2
3,198,138	8/1965	Melcher	105/72.2
3,877,390	4/1975	Wallace .	
4,497,257	2/1985	White .	
4,537,137	8/1985	White .	
4,917,020	4/1990	Wicks et al.	105/72.2
5,016,544	5/1991	Woollam .	
5,103,740	4/1992	Masse .	
5,186,109	2/1993	Madison .	
5,642,673	7/1997	Lucky	105/72.2
5,660,115	8/1997	Shimon et al.	105/72.2

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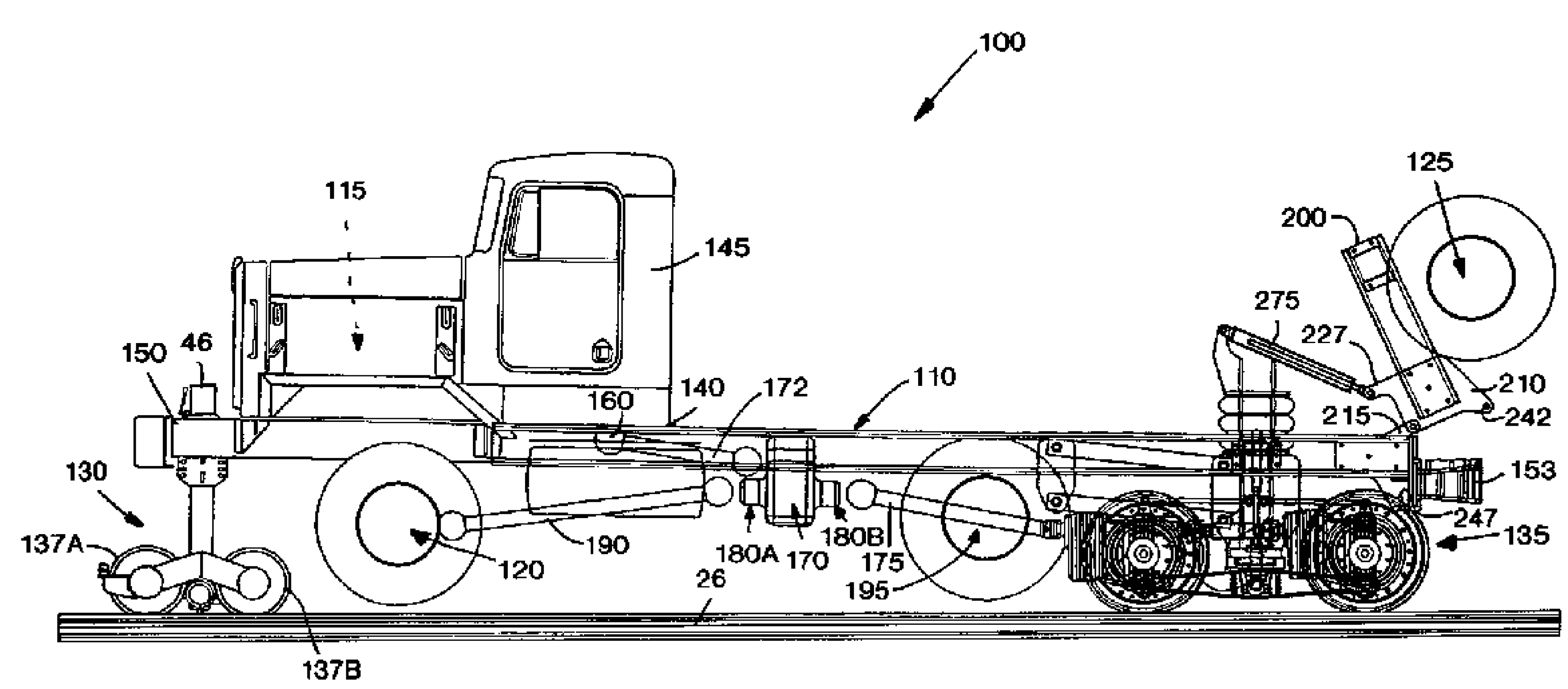
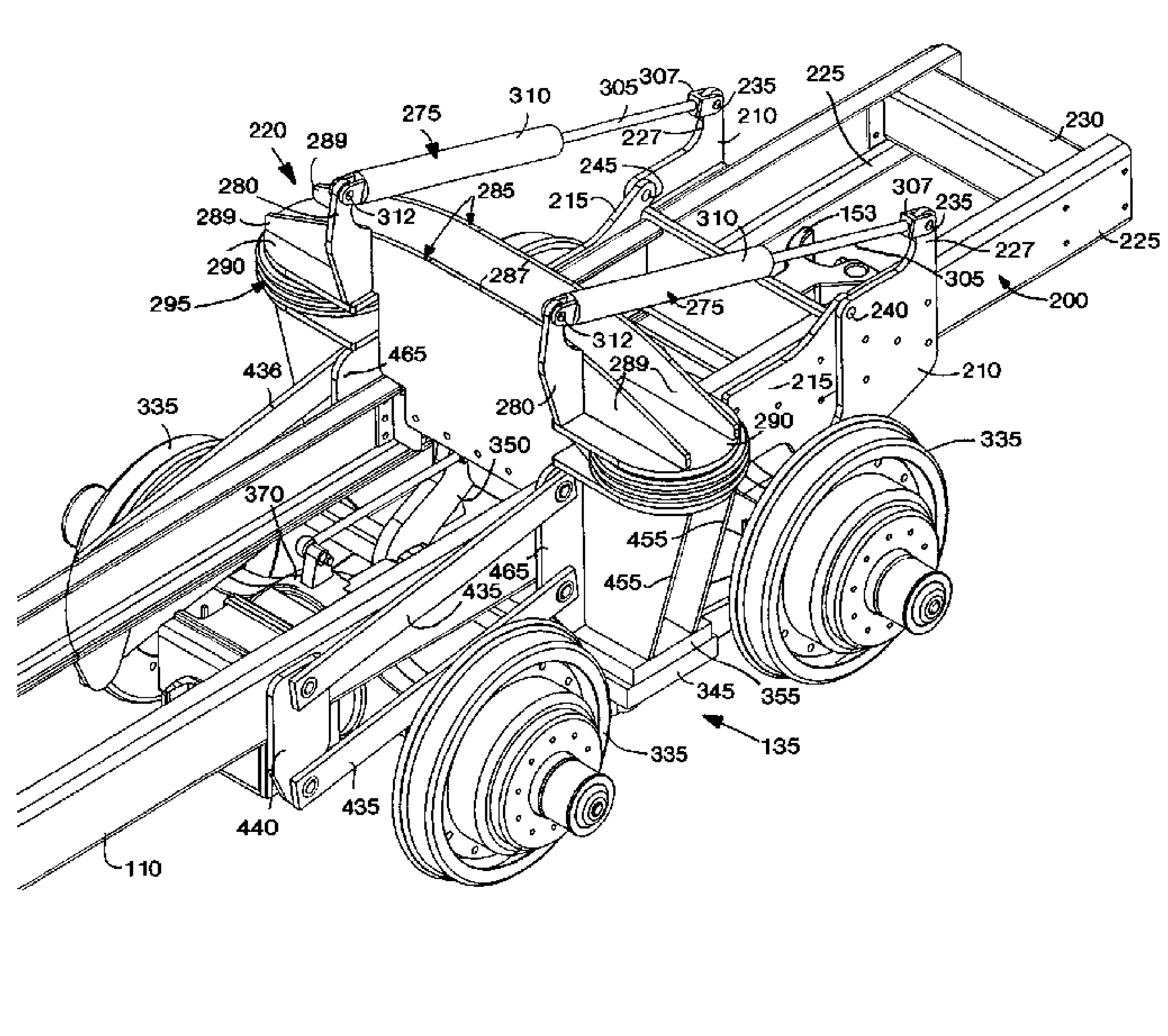
Attorney, Agent, or Firm—Eckert Seamans Cherin & Mellott

[57] **ABSTRACT**

A road and rail vehicle has a truck tractor vehicle frame such that it is street legal, but also provides sufficient power to move freight cars on low density rail lines or at other desired locations. The vehicle has a transfer case to provide front wheel drive by road wheels when the vehicle is in a road or highway mode and to provide rear wheel drive by rail wheels when in a rail mode. The vehicle has a front guide rail wheel unit which moves front rail wheels between an upper road position and a lower rail position. A rear or back axle has right and left back road wheels thereon and is movable between an upper rail position and a lower road position.

9 Claims, 10 Drawing Sheets





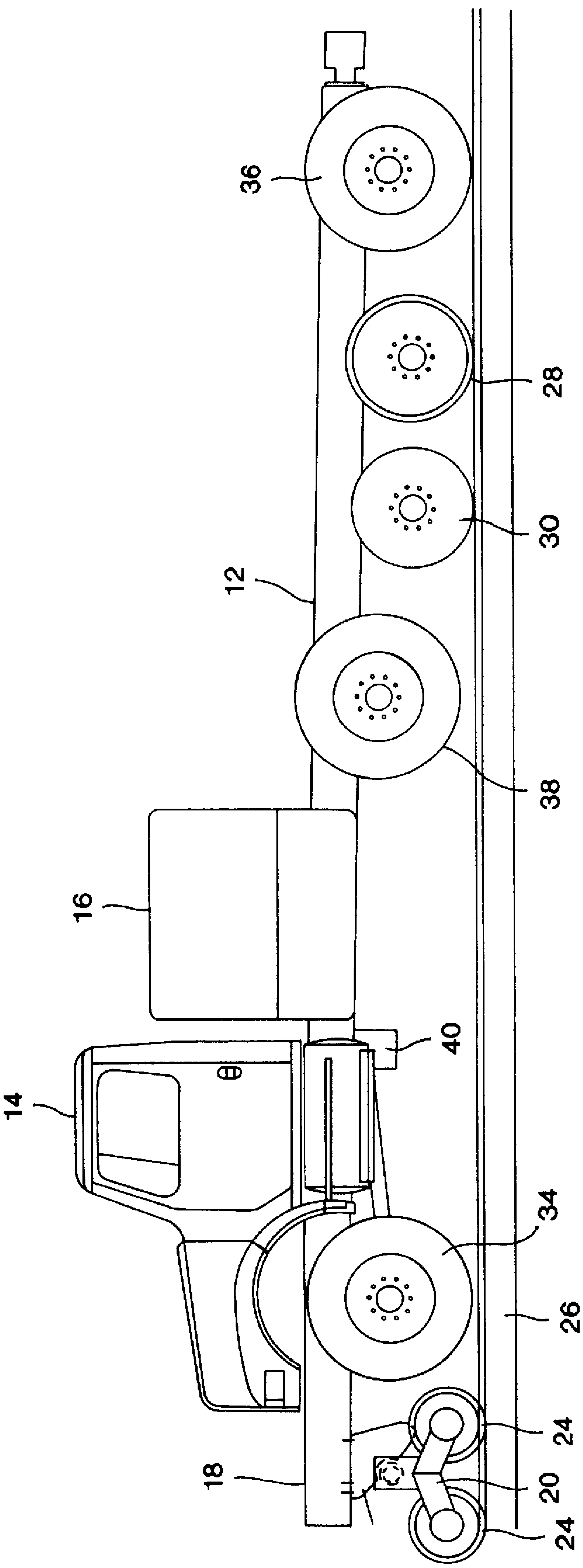


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FIG. 1

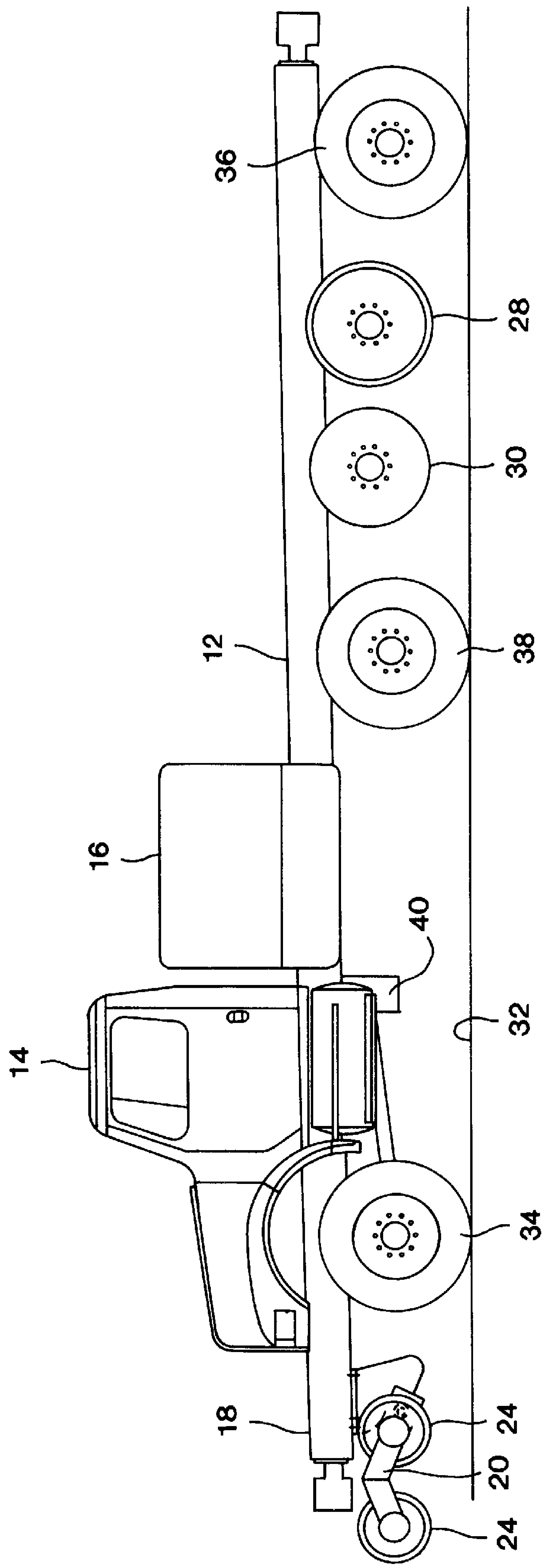

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FIG. 2

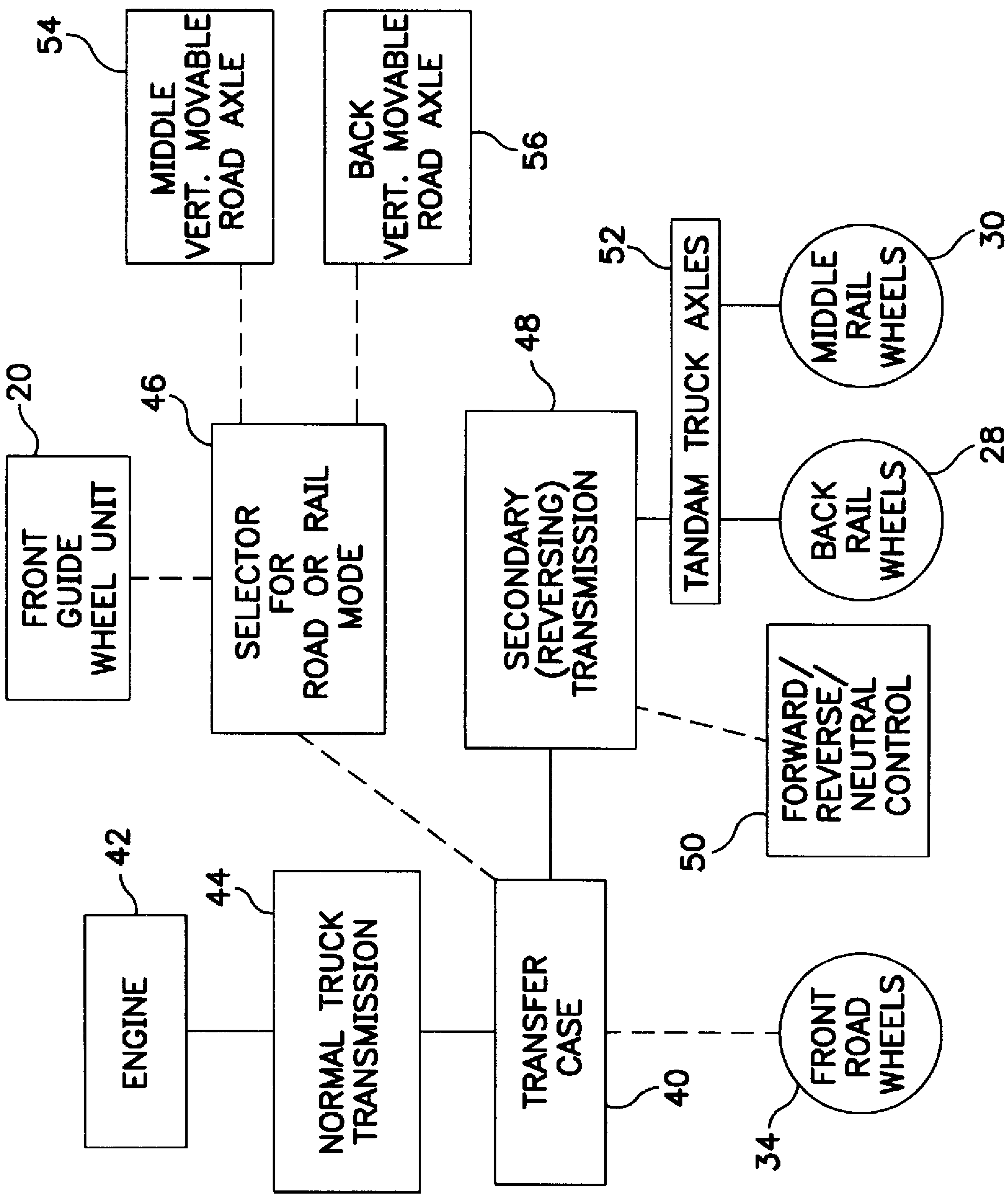

ENGINE
42
NORMAL TRUCK TRANSMISSION
44
TRANSFER CASE
40
FRONT ROAD WHEELS
34
FRONT GUIDE WHEEL UNIT
20
SELECTOR FOR ROAD OR RAIL MODE
46
MIDDLE VERT. MOVABLE ROAD AXLE
54
BACK VERT. MOVABLE ROAD AXLE
56
SECONDARY (REVERSING) TRANSMISSION
48
FORWARD/ REVERSE/ NEUTRAL CONTROL
50
TANDAM TRUCK AXLES
52
BACK RAIL WHEELS
28
MIDDLE RAIL WHEELS
30

FIG. 3

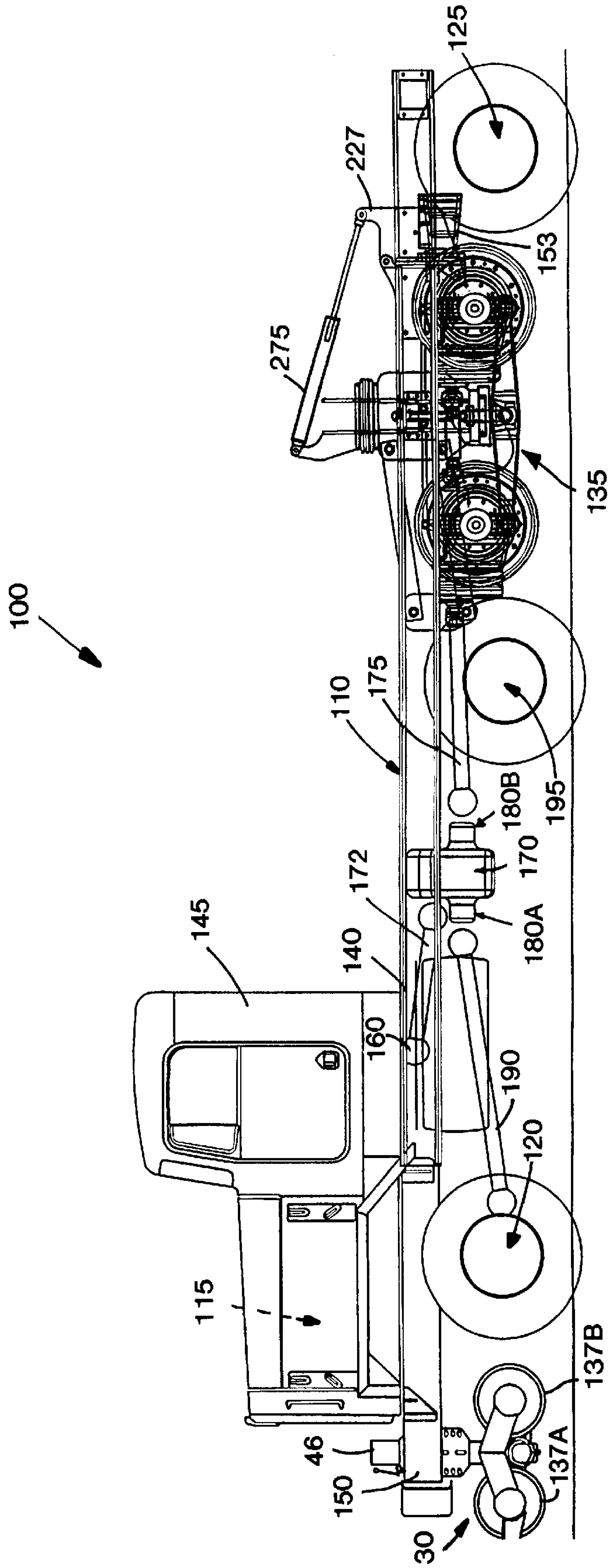
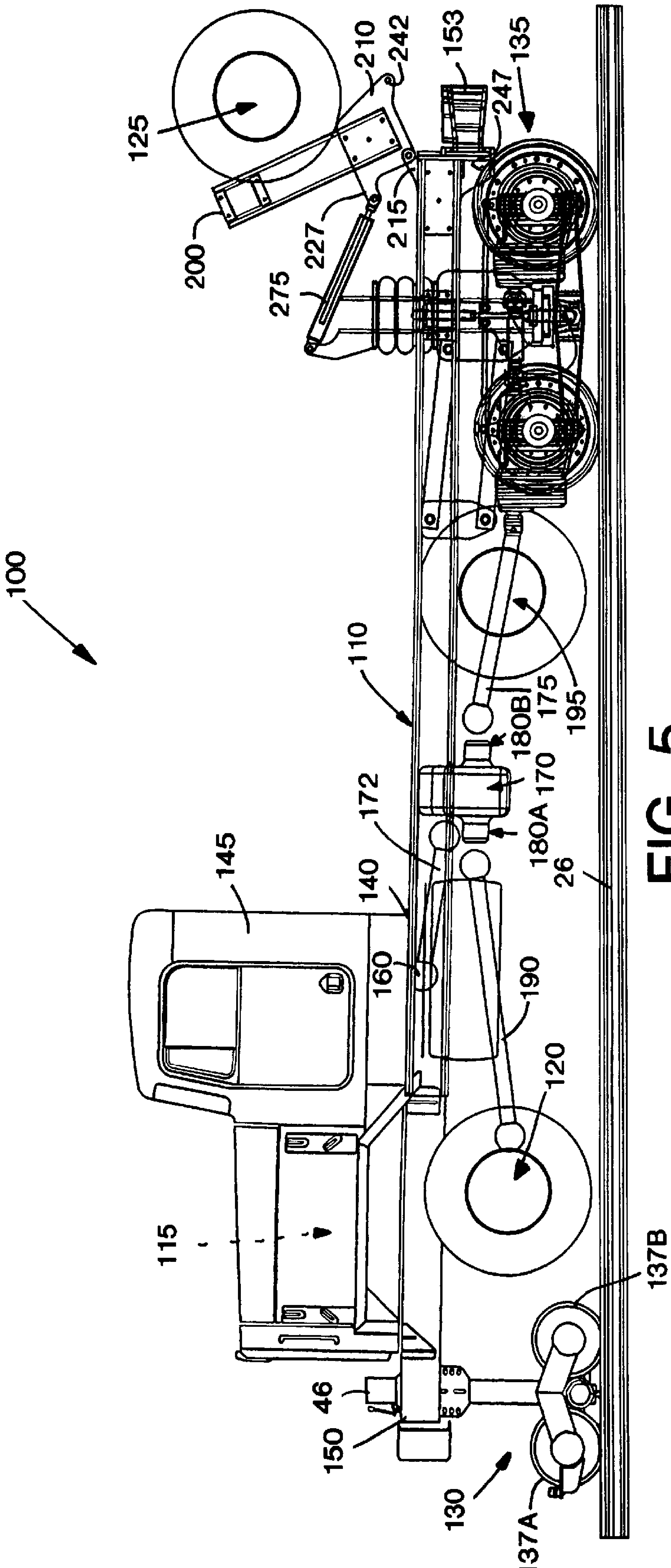

100
125
227
153
275
135
110
175
195
180B
170
172
180A
145
140
160
190
120
115
137B
46
150
137A
130

FIG. 4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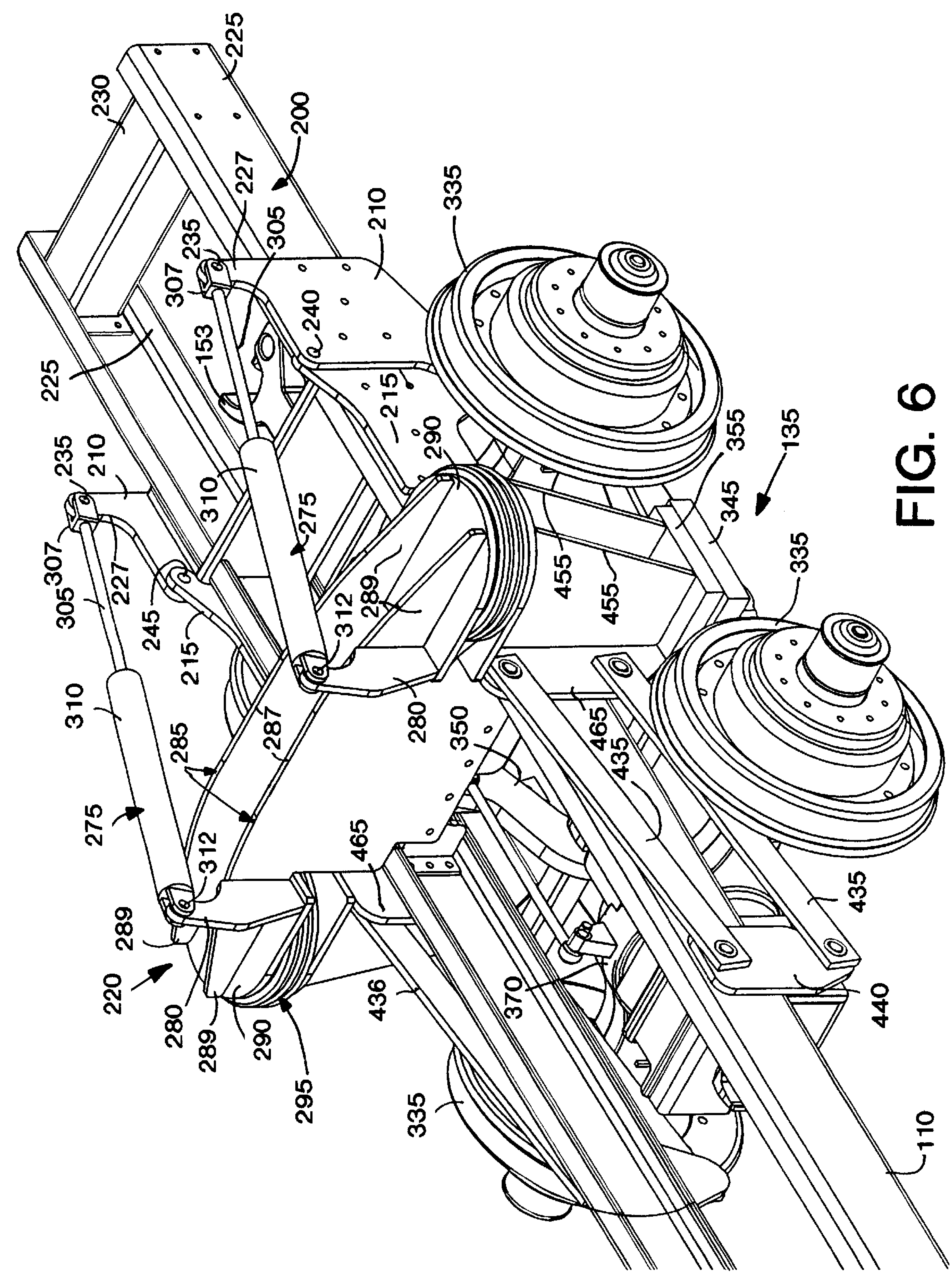
110
115
120
125
130
135
137A
137B
140
145
150
153
160
170
172
175
180A
180B
190
195
200
210
215
227
242
247
275
26
46

FIG. 5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289
455
307
227
245
312
305
215
280
465
310
285
287
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289
465
435
220
280
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290
370
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436
295
335
110

FIG. 6

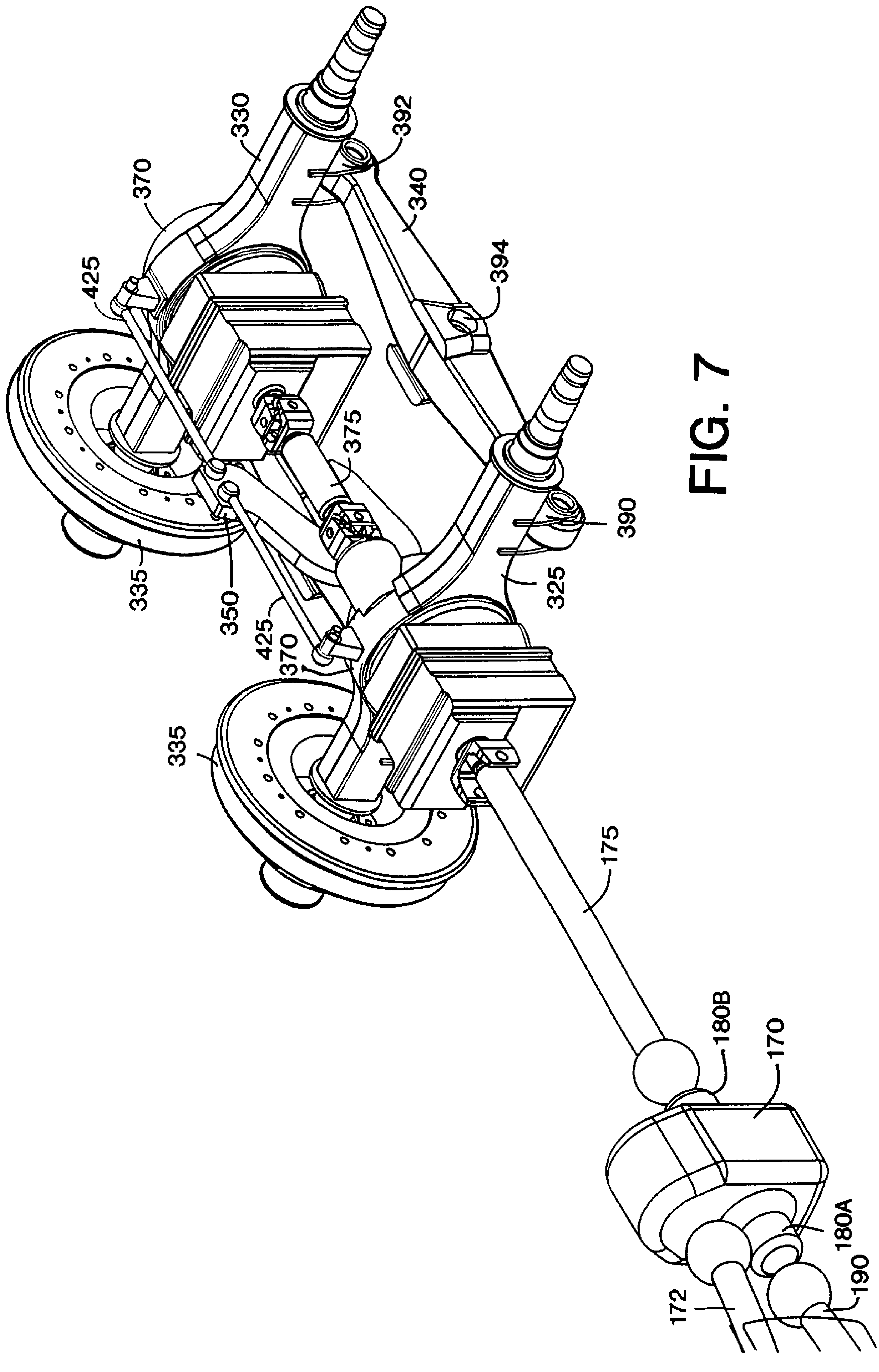
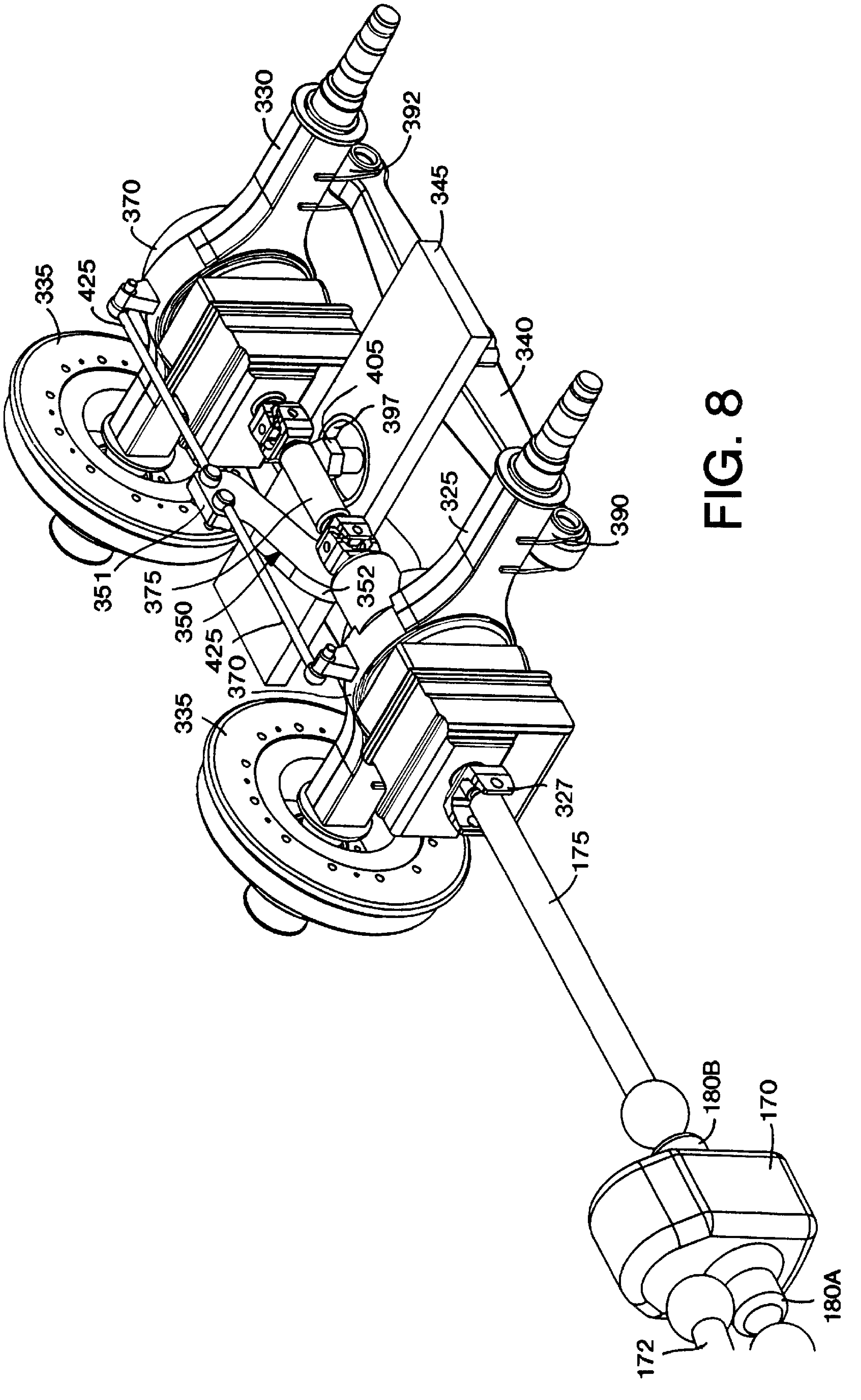

330
392
370
340
425
394
375
390
325
335
350
425
370
335
175
180B
170
180A
190
172

FIG. 7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392
370
345
335
425
405
340
397
325
390
351
375
350
352
425
370
335
327
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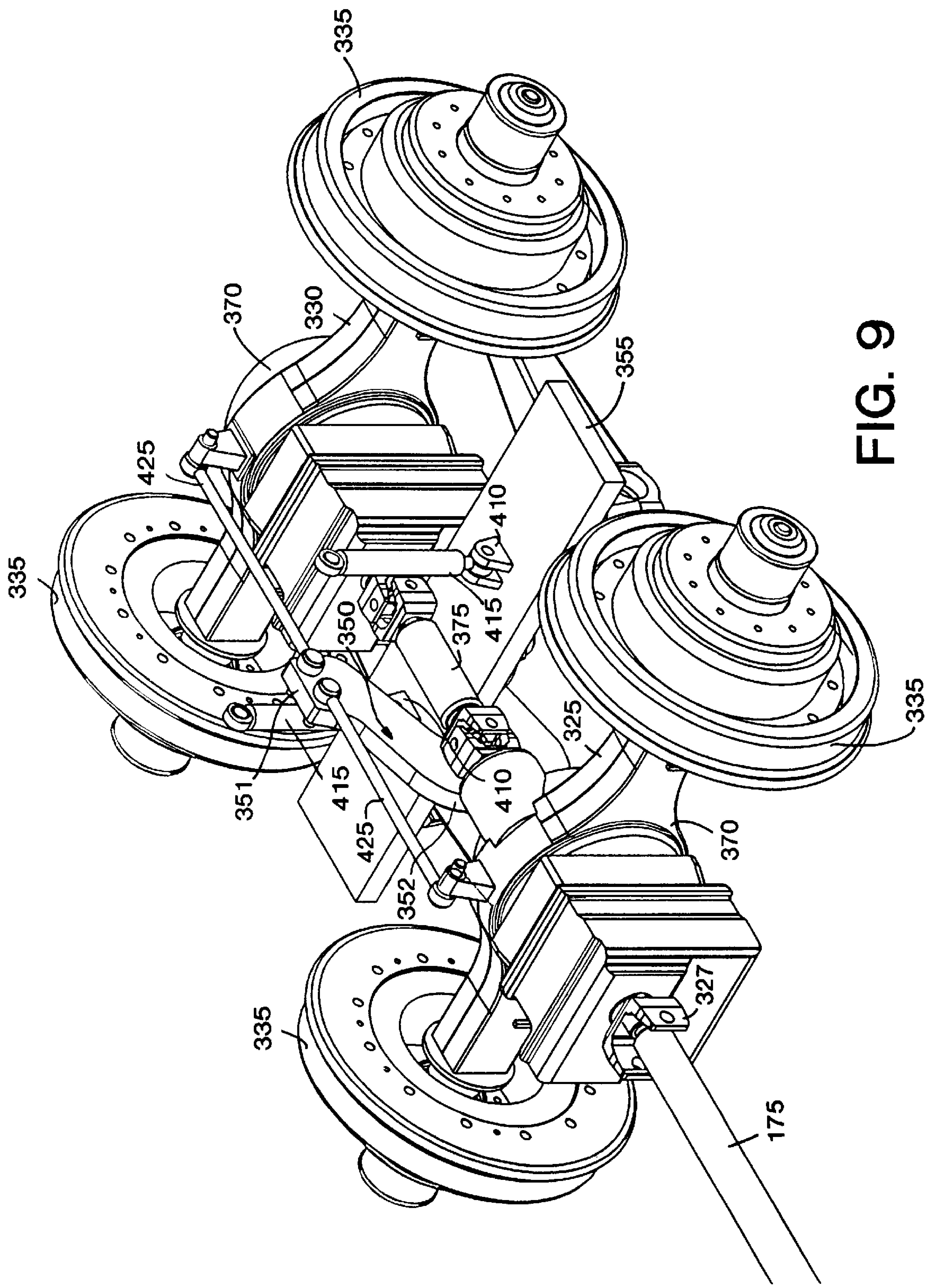
170
180A
172

FIG. 8


335
370
330
355
425
410
335
415
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375
415
335
351
415
325
410
425
370
352
327
335
175

FIG. 9

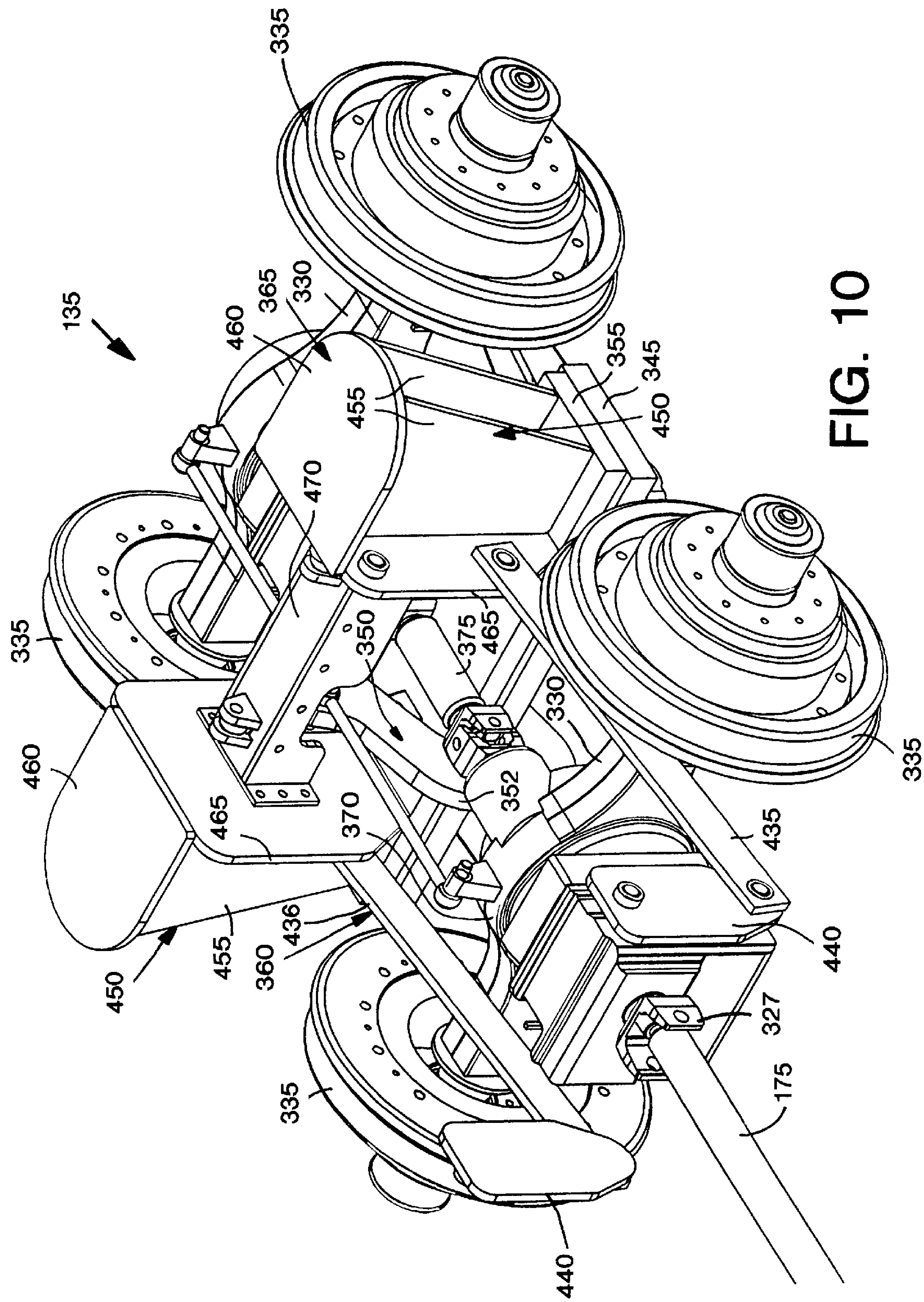
135
335
365
330
460
455
470
355
345
450
335
350
375
465
330
352
335
460
465
370
435
436
455
360
450
440
327
335
175
440

FIG. 10

ROAD AND RAIL VEHICLE USING RAIL WHEEL DRIVE AND APPARATUS

This is a continuation-in-part of application Ser. No. 08/505,025, filed Jul. 21, 1995 now U.S. Pat. No. 5,619,931.

BACKGROUND OF THE INVENTION

The present invention relates to a rail engagement apparatus having powered rail engagement wheels for a road vehicle. Further, this invention relates to a vehicle having such an apparatus mounted to it.

As used herein, a road vehicle is a vehicle having wheels which contact a highway or other road, as opposed to only having wheels which roll on rails on a railroad track.

Railroad service crews often have to go to various places along a railroad track in order to make repairs and inspections. Depending upon the type of service which is performed and other factors, the service crew may ride to the work site using a rail vehicle or using a road vehicle, such as a truck or car. Since the best way to a work site may include travel along a road and travel along a railway, service crews and other rail workers often have used road vehicle having a rail engagement or guide wheel apparatus mounted on them. Such cars or trucks may travel along a highway or other road with road wheels engaging the road. Upon getting to an appropriate place along the railway, the rail engagement apparatus is operated such that railway wheels are lowered from the vehicle until the vehicle is bound to the railway. Usually such vehicles include an apparatus at the front of the vehicle which lifts the front road wheels off the ground when two front railway wheels engage rails and an apparatus at the back of the vehicle, which apparatus secures the back of the vehicle to the rails by two back railway wheels. The two back railway wheels allow the regular road wheels to contact the rails or other surface such that the road wheels may provide traction to move the vehicle even when the two front railway wheels and two back railway wheels have secured the vehicle to the rail. When the vehicle wishes to leave the railway, the two front railway wheels and the two rear railway wheels are retracted or lifted up such that the vehicle may again run along the road.

Various structures have been used to allow railway wheels to be attached to road vehicles. Although such structures have been generally useful at moving the railway wheels between an upper position in which the vehicle may travel along a highway or other road and a lower position in which the vehicle travels along a railway, such structures have often been subject to one or more of several disadvantages.

It has been desirable to have a road vehicle which can also move loads along a railroad track. Various vehicles having rubber tires for highways and rail guide wheels for rails have been used to move railway freight cars with varying degrees of success. Such road/rail vehicles may advantageously move along highways until they reach a railroad track where they can lower their rail engagement wheels and travel along the railroad track. They may then move loads such as rail bound vehicles secured to a rail/highway vehicle. Such rail/highway vehicles may work satisfactorily for some purposes, but the rubber road tires wear out and rapidly fail at higher loads. That is, such rail/highway vehicles are powered by the rubber road tires even though they are bound to the rails when their rail engagement wheels are down. When the loads on the rubber road tires are too high, the tires simply wear out rapidly.

Special vehicles for moving freight cars have been developed, but they are limited to very slow road speeds.

These vehicles are basically small locomotives having rail engagement wheels which do not raise and lower. Instead, such small locomotives are modified to have rubber tires which raise and lower such that the vehicle can travel on road surfaces off of rails. However, the special tire mounting and drive arrangements for the rubber tires greatly restrict the road speed of such vehicles. Such vehicles travel on road surfaces by using frictional contact between driven rail engagement wheels and road wheels which have been lowered to a road position. In other words, such special vehicles can travel independent of the rails from one side of a rail yard to another side, but cannot be used on a regular road without going so slowly as to substantially impede the flow of other traffic. More importantly, such vehicles do not use road vehicle frames (meaning frames of cars, trucks, or other street legal vehicles). Instead, they use locomotive or other rail vehicle frames and are accordingly not street legal for normal transit on a highway or other road.

Regular locomotives have often been used for moving freight or other rail cars along light traffic density outlying rail lines. For example, if a given manufacturer is sending two freight cars a day to a rail yard on further travel, a locomotive could be used to move the two freight cars. (Alternately, the locomotive would pick up freight cars at the manufacturer only after a larger number of freight cars are ready, but this may slow the manufacturer's ability to ship in timely fashion.) If the locomotive is tied up moving a small number of freight cars, it cannot be used at other locations where its great power is needed. Further, moving the locomotive by rail to the rail line adjacent the manufacturer's plant requires that track occupancy and rail signaling be handled properly so that the locomotive is switched to the right path and does not collide with (or cause significant delays for) other trains using some of the same tracks.

The present inventor's prior U.S. Pat. Nos. 5,154,124, issued Oct. 13, 1992, and 5,186,109, issued Feb. 16, 1993, both assigned to the assignee of the present application, relate to different apparatus for moving a highway vehicle along a railroad track. Both of those patents are hereby incorporated by reference.

OBJECTS AND SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide a new and improved apparatus for allowing a highway vehicle to move along a railroad track.

A further object of the present invention is to provide a new and improved vehicle which can move along highways and along railroad tracks.

A further object of the present invention is to provide an apparatus and a vehicle for rail/highway use which will work satisfactorily with heavy loads such as freight cars.

Yet another object of the present invention is to provide a vehicle, an apparatus, and a method for moving rail cars on light traffic density outlying rail lines.

A further object of the present invention is to provide a vehicle and apparatus for road/rail use which avoids damaging rubber tires when traveling on rails.

Yet another object of the present invention is to provide a vehicle and apparatus for road/rail use which can move relatively quickly on both roads and rails.

The above and other features of the present invention are realized by a road and rail vehicle including a vehicle frame having a front end, a rear end, a right side, and a left side. A first axle having a right road wheel and a left road wheel operably mounted thereon in spaced-apart relation to one another, is mounted on the vehicle frame adjacent to the front end. A second axle having a right road wheel and a left road wheel operably mounted thereon in spaced-apart relation to one another is mounted on the vehicle frame rearwardly of the first axle. A third axle having a right road wheel and a left road wheel operably mounted thereon in spaced-apart relation to one another is pivotally mounted to the rear end of the vehicle frame so as to be pivotally movable into and out of engagement with a road surface. A first rail wheel assembly is provided that includes at least a right rail wheel and at least a left rail wheel operably disposed in spaced-apart relation to one another on a rail axle. The first rail wheel assembly is positioned adjacent to the front end of the vehicle frame and is movable into and out of engagement with the rails of a railroad track. A rail drive assembly is provided that includes at least a right rail-drive wheel and at least a left rail-drive wheel that are operably mounted to an axle on a carriage. The carriage is movably mounted to the rail side of the vehicle frame, between the second and the third axles. Advantageously, the rail drive assembly is movable relative to the frame so as to move the rail-drive wheels into and out of engagement with the rails of the railroad track. Drive means for propelling the vehicle are provided along with a mode controller. The mode controller is operable to select between (i) a road mode in which the road wheels engage a road wherein the vehicle is propelled by driving the road wheels independent of the rail wheels and (ii) a rail mode wherein the first rail wheel assembly and the rail-drive wheels engage the rails of the railroad track. In the rail mode, the vehicle is propelled by driving the rail-drive wheels with all of the road wheels offset from engagement with any surface.

BRIEF DESCRIPTION OF THE DRAWING

These and other objects, features and advantages of the present invention will be more fully disclosed in, or rendered obvious by, the following detailed description of the preferred embodiment of the invention which is to be considered together with the accompanying drawings wherein like numbers refer to like parts and further wherein:

FIG. **1** is a side view of the present invention in a rail mode for traveling along railroad tracks;

FIG. **2** is a side view of the present invention in a road mode (could also be called highway mode) for traveling along a road;

FIG. **3** is a simplified block diagram showing various components of the invention;

FIG. **4** is a side view of an alternative embodiment of the present invention in a road or highway mode for traveling along a road;

FIG. **5** is a side view of the embodiment shown in FIG.4, but in a rail mode for traveling along railroad tracks;

FIG. **6** is a perspective view of the rail drive assembly, including a portion of the flip-up tag axle; and

FIGS. **7**–**10** are perspective views of the rail drive assembly with portions of the flip-up tag axle removed for clarity of illustration.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning initially to FIG. **1**, a preferred embodiment of the present invention is a road and rail vehicle **10** having a truck tractor vehicle frame **12** with a cab **14** thereon. A box **16** may house various air equipment used in known fashion for controlling vertically movable axles, air brakes, etc.

A frame extension **18** has been mounted at the front of vehicle **10** for holding a rail wheel guide unit **20** on mount plate **22**. The various wheels and other components discussed herein are symmetric with respect to right and left sides of the vehicle such that the construction of the right side components will be understood from the illustrations and discussions of left side components herein.

The rail guide unit **20** has first and second front left rail engagement wheels **24** which are flanged steel wheels for non-powered engagement with left rail **26** (i.e., wheels **24** are not driven when the vehicle is in the illustrated rail mode with the rail wheels **24** in a lower, rail position. The frame extension **18** and rail guide unit **20** may be of a known types used for various previous road vehicles modified to run on rails. However, unlike various of the common road vehicles modified to run on rails which use road tires for propulsion even in the rail mode, the vehicle **20** is propelled in the rail mode by driving rail engagement wheels.

Driving rail engagement wheels (i.e., rail engagement wheels which are driven or powered to propel the vehicle) on the vehicle **10** include left back steel flanged rail engagement wheel **28** and left middle (i.e., middle meaning between the back rail wheel **28** and front rail wheels **24**, not necessarily centered) steel non-flanged wheel **30**. Each of the rail wheels **28** and **30** (including the pair on the non-illustrated right side of the vehicle) engages a rail for propelling the vehicle along when in the rail mode. The left middle rail wheel **30** and similar right wheel are non-flanged such that they do not cause problems when the vehicle **10** goes around a curve. Although the middle rail wheel **30** is illustrated somewhat offset in the rail direction from back rail wheel **28**, the middle wheel **30** might alternately be just in front of wheel **28**.

Continuing to view FIG. **1**, but also considering the view of FIG. **2** where the rail wheels **24** are in an upper, road position and the rail wheels **28** and **30** are in a road position (i.e., they are offset vertically from the road surface **32**), it will be appreciated that vehicle **10** may travel on highways or other roads surface such as surface **32**. A front road wheel **34** is in a road position in which it contacts surface **32** in FIG. **2**, whereas road wheel **34** is in a rail position (i.e., vertically offset from and not contacting any surfaces therebelow) in FIG. **1**. Note that, in the preferred embodiment illustrated, the road wheel **34** (as well as a similar wheel on the right side of the vehicle) is not moved up or down relative to frame **12** to change from its rail position to its road position. Instead, it is in a road position when the tire of wheel **34** contacts a surface such as **34** below it due to the lifting of rail wheels **24** relative to frame **12**. In similar fashion, wheel **34** is in a rail position offset from below surfaces when the rail wheels **24** have been lowered to their rail position of FIG. **1**.

When in their road positions of FIG. **2**, the rail wheels **28** and **30** have not been moved relative to the frame **12** from their rail positions of FIG. **1**. Instead, the change in the positions of wheels **28** and **30** is relative to surfaces such as **32** which are below the vehicle, this change being accomplished by lowering back and middle road wheels **36** and **38** from rail positions (FIG. **1**) to road positions (FIG. **2**) relative to frame **12**. In FIG. **1**, the road wheels **36** and **38** are lifted relative to the surfaces below vehicle **10** until the rail wheels **28** and **30** engage rail **26**. Note that in FIG. **1**, the wheels **36** and **38** (more specifically the tires of these wheels) are not in contact with the surfaces therebelow, but are elevated from any such surfaces.

Accordingly, the preferred embodiment vehicle **10** of the present invention provides vertical movement of front rail wheels **24**, middle road wheels **38**, and back road wheels **36** for changing from a rail mode (FIG. **1**) for traveling along rails to a road mode (FIG. **2**) for traveling on roads. (Wheels **28**, **30**, and **34** are vertically stationary, meaning not vertically movable relative to frame **12**, in the preferred embodiment.) In the rail mode, wheels **24**, **28**, and **30** are in rail positions contacting below surfaces (i.e., rails) and wheels **34**, **36**, and **38** are in rail positions elevated from any below surfaces. In the road mode, wheels **24**, **28**, and **30** are in road positions elevated from any below surfaces and wheels **34**, **36**, and **38** are in road positions contacting surfaces therebelow.

The vertical movement of wheels **36** and **38** may be accomplished using known tag axles (not shown) which use air to raise and lower the axles on which wheels **36** and **38** are mounted. Alternately, tag axles of known design using springs to raise the axles and air to lower the axles may be used.

The propulsion arrangement of vehicle **10** will be discussed with reference to FIG. **3** and continuing to consider FIGS. **1** and **2**. A known type of transfer case **40** with gear train therein is used to select which wheels are driving wheels (i.e., used for propulsion) in a given mode. Specifically, transfer case **40** supplies traction power from engine **42** via normal truck transmission **44** to front road wheels **34** when in the road mode of FIG. **2**. However, when rail mode is selected on a selector **46** (which together with transfer case **40** may be considered as a mode controller), the transfer case **40** no longer supplies power to front road wheels **34**. Instead, the transfer case **40** now supplies power to a secondary transmission **48**. The secondary transmission **48**, which is not powered when the selector **46** is in a road mode, is preferably a reversing transmission with a control **50** operable in known fashion to switch from forward, reverse, and neutral positions. Therefore, the maximum reverse and forward speeds via transmission **48** will be the same. In the rail mode, transmission **48** powers the back rail wheels **28** and middle rail wheels **30** by way of tandem truck axles **52** (one middle rail axle and one back rail axle). The axles **52** are called rail axles in that they have rail wheels **28** and **30** thereon, but they may be of known design for tandem truck axles such as double reduction thru-drive tandem axles. One can alternately modify such known truck tandem axles slightly by narrowing the tread width to correspond to rail wheels **28** and **30**.

Significantly, and as will be apparent from FIG. **3**, the road wheels **34** propel the vehicle in the road mode independent of all of the rail wheels. That is, and unlike some prior designs, power to road driving wheels **34** is not supplied via any of the rail wheels. This allows vehicle **10** to travel at reasonable highway speeds and not be limited to the low speeds associated with vehicles where road wheels are driven via rail wheels.

The selector **46** may be of known type of control for a transfer case and may advantageously and in straightforward fashion incorporate controls for raising and lowering the front guide wheel unit **20** corresponding respectively to road mode and rail mode. Further, selector **46** may incorporate controls for raising and lowering a middle road axle **54** and a back road axle **56** corresponding respectively to rail mode and road mode. Such air, air/spring, hydraulic, or other known lifting/lowering mechanisms may also be used for the actual lifting and lowering of rail guide wheel unit **20**. Thus, although not shown in FIG. **3** for ease of illustration, a lift/lower mechanism is operably connected between selector **46** and each of components **20**, **54**, and **56**.

Advantageously, the driving wheels (driving rail wheels **28** and **30** and driving road wheels **34**) are not moved relative to frame **12**, whereas the other wheels (which are non-powered) are moved up and down relative to frame **12**. Also, use of rear wheel drive in rail mode, via rail wheels **28** and **30**, allows for better loading when rail car coupler **58** has a load of one or more freight or other rail cars coupled to it for pulling by vehicle **10**. (The rail car coupler **58** may be powered vertically in order to transfer the load from the rail cars to the vehicle **10** as this will help obtain sufficient tractive effort for pulling/pushing heavy loads on a railroad tracks.) Use of front wheel drive in the road mode minimizes or avoids difficulties and complexities one might otherwise encounter if trying to power the vehicle from the same end (front or back) in both road mode and rail mode.

Note that the wheels **36** and **38** may have two wheels **36** and two wheels **38** (not visible in FIGS. **2** and **3**) on each side of the vehicle **10** in known fashion.

In an alternative embodiment of the present invention, illustrated in FIGS. **4**–**10**, a road rail vehicle **100** may also comprise a vehicle frame **110**, a propulsion system **115**, a drive/steer axle **120**, a flip-up tag axle **125**, a front rail engagement assembly **130**, and a rail drive assembly **135**.

More particularly, road and rail vehicle **100** comprises a truck tractor vehicle frame **140** having an operator's cab **145**. A frame extension **150** is mounted at the front end of vehicle frame **110** for supporting front rail engagement assembly **130**, as will hereinafter be disclosed in further detail. A shelf coupler or draw bar **153** of a type that is well known in the art is mounted at the rear end of vehicle frame **110** (FIGS. **4**, **5**, and **6**) for coupling road rail vehicle **100** to other vehicles. Shelf coupler **153** acts to transfer downward pressure to rail drive assembly **135**, when vehicle **100** is in the rail mode and is coupled to a rail vehicle, as will hereinafter be disclosed in further detail.

Propulsion system **115** is similar to that discussed in connection with vehicle **10** in that it is mounted on vehicle frame **110**, and comprises one of the well known types of engine that are adapted to propel a wheeled vehicle along either a road or a railroad track. As with vehicle **10**, power from the engine is transmitted, via a conventional transmission **160**, to a modified reversing transmission **170**, via drive shaft **172**. More particularly, reversing transmission **170** is modified so as to be capable of driving output shafts **175** and **190** (FIGS. **4** and **5**) in either of two directions, i.e., either clockwise or counterclockwise. Two conventional declutches **180**A and **180**B are operatively mounted to each end of modified reversing transmission **170** so as to engage selectively with, and transfer motive force to, drive/steer axle **120** and/or rail drive assembly **135**. Advantageously, modified reversing transmission **170** allows drive/steer axle **120** to be driven in the same direction as rail drive assembly **135** when vehicle **100** is moving in either the forward or reverse direction.

Alternatively, power from the engine may be transmitted, via a conventional transmission, to a conventional transfer case and then to a modified reversing transmission **170**. In this embodiment of the invention, modified reversing transmission **170** is equipped with a neutral position. During road use, i.e., when drive/steer axle **120** is driven by means of its engagement with the conventional transfer case, the modified reversing transmission is placed in a neutral position. When in rail mode, the conventional transfer case declutch (that engages drive/steer axle **120**) is disengaged, and modified reversing transmission **170** is engaged so as to allow movement of road rail vehicle **100** in either a forward or backward direction along the railroad track.

Still referring to FIGS. **4** and **5**, rail guide assembly **130** is substantially similar to rail guide unit **20** in that it has first and second front rail engagement wheels **137**A and **137**B which are flanged steel wheels for non-powered engagement with rails **26**. In particular, wheels **137**A and **137**B are not driven when vehicle **100** is in the rail mode shown in FIG. **5**. Both frame extension **150** and rail guide assembly **130** may be of a known type that is often used in connection with various conventional road vehicles modified to run on rails. However, unlike conventional road vehicles that are modified to run on rails and which use road tires for propulsion even in the rail mode, vehicle **100** is propelled in the rail mode by driving a plurality of rail engagement wheels disposed on rail drive assembly **135**, as will hereinafter be disclosed in further detail.

Drive/steer axle **120** is positioned on vehicle frame **110** so as to be disposed rearwardly of front rail guide assembly **130**. Drive/steer axle **120** is operably connected to modified reversing transmission **170**, via front drive shaft **190**, and includes right and left road wheels of the type that are well known for use on conventional road surfaces. Drive/steer axle **120** is of conventional construction.

Support axle **195** is positioned rearwardly of drive/steer axle **120** and adjacent to rail drive assembly **135** on vehicle frame **110**. Support axle **195** also includes right and left road wheels. The positioning of support axle **195** rearwardly of drive/steer axle **120** and adjacent to rail drive assembly **135** provides structural support for rail drive assembly **135** on vehicle frame **110** when rail drive assembly **135** is not engaging rails **26**, i.e., during road mode operation of vehicle **100**.

Referring now to FIGS. **4–6**, flip-up tag axle **125** comprises a frame **200**, two lever-brackets **210**, two pivot-brackets **215**, and a lift assembly **220**. More particularly, frame **200** comprises at least a pair of spaced-apart structural members **225** that are joined at their distal end by a cross-beam **230**. A lever-bracket **210** is fastened to the outer surface of the proximal end of each structural member **225**. Each lever-bracket **210** is formed from a planer plate of metal or the like, and comprises a cylinder-pivot hole **235**, a frame-pivot hole **240**, and a lock-hole **242**, that are each defined in spaced-relation to one another through its thickness. A corner portion of each lever-bracket projects upwardly relative to the proximal end of each structural member **225** thereby providing a lever arm **227**. Advantageously, a cylinder-pivot hole **235** is defined in an upper portion of each lever arm **227**.

Each pivot-bracket **215** is also formed from a planer plate of metal or the like, and comprises a pivot hole **245** and a lock-hole **247** that are defined through its thickness at opposing outer corners thereof. Pivot-brackets **215** are fastened to the right and left outer surfaces of the rear end of vehicle frame **110** adjacent to the proximal end of frame **200**. When fully assembled to vehicle frame **110**, lever-bracket **210** is pivotally mounted to pivot-bracket **215**, via a pivot pin inserted through pivot-holes **240** and **245**, so that lever-bracket **210** is positioned in overlying confronting realtion to pivot-bracket **215** (best illustrated in FIG. **6**).

Lift assembly **220** is mounted on vehicle frame **110**, above rail drive assembly **135**, and comprises actuation cylinders **275**, cylinder-brackets **280**, support members **285**, pressure plates **290** and air bags **295**.

More particularly, actuation cylinders **275** may comprise either hydraulic or pneumatic cylinders of a type that are well known in the art. Actuation cylinders **275** each comprise a piston rod **305** and a cylinder housing **310**. The free end of each piston rod **305** includes a yoke coupling **307** that is adapted to pivotally couple the free end of piston rod **305** to cylinder-pivot hole **235** of lever-bracket **210**, via insertion of a conventional pivot pin therethrough. The free end of each cylinder housing **310** includes a yoke coupling **309** having a pivot-hole **312** defined therein that is adapted to pivotally couple the free end of cylinder housing **310** to an upper portion of cylinder-bracket **280**, via the insertion of a conventional pivot pin therethrough.

Cylinder-brackets **280** comprise planer plates of metal or the like that are oriented vertically relative to frame **110**, and are fastened along one edge to support member **285** and along another edge to pressure plate **290**. At an upper end of each cylinder-bracket **280** is defined a pivot-hole that is adapted to receive a conventional pivot pin. Cylinder-bracket **280** has a thickness selected so as to be pivotally received within yoke coupling **309** of cylinder housing **310** so as to position the pivot holes in cylinder-brackets **280** in coaxial alignment with pivot-hole **312**.

Support members **285** comprise substantially T-shaped structural support elements that include a central trunk portion **287** and a pair of laterally disposed wing portions **289**, as best illustrated in FIG. **6**. Central trunk portion **287** is adapted to be mounted transversely on vehicle frame **110** so as to stand on end in substantially perpendicular relation to the longitudinal axis of vehicle **100**. In this arrangement, wing portions **289** project outwardly from the top right and left sides, respectively, of central trunk portion **287** and outwardly from both the right and left sides of vehicle frame **110**.

A pressure plate **290** is fastened to the lower edge of each wing portion **289** so as to provide a broad surface adapted to rest on and be engaged by, a corresponding upper surface portion of a corresponding airbag **295**. Right and left airbags **295** are mounted on lift assembly **220** and are of conventional construction. The vertical movement of rail drive assembly **135** is accomplished, in part, by pumping air into, or releasing air from, airbags **295**.

Referring now to FIGS. **7–10**, rail drive assembly **135** includes a first axle **325**, a second axle **330**, rail wheels **335**, two walking beams **340**, a lower pivot-plate **345**, a torque reaction plate **350**, an upper pivot-plate **355**, two four-bar linkage assemblies **360**, and a lift assembly support structure **365**. More particularly, first axle **325** and second axle **330** are positioned in transverse relation to vehicle frame **110** so as to be disposed in spaced-apart, parallel relation to one another. Axles **325**,**330** are of conventional construction.

Four rail wheels **335** are disposed, one each, on the outer ends of each axle **325**,**330** in the manner well known in the art. Each axle **325**,**330** includes a conventional axle housing **370** that is adapted to transfer rotational motive force to rail wheels **335**, via a conventional gear system disposed within axle housing **370** as is well known in the art.

Drive shaft **175** is operatively coupled to axle housing **370** of first axle **325** by a conventional yoke and spline shaft slip joint **327**. Drive shaft **175** transfers rotational motive force to rail drive assembly **135** from modified reversing transmission **170**. A coupling shaft **375** is operatively mounted between the axle housings **370** of first and second axles **325**, **330** so as to transfer rotational motive force to second axle **330**.

First axle **325** and second axle **330** are also structurally coupled together by a pair of walking beams **340**. Walking beams **340** are adapted to be mounted between axles **325**, **330** in mutually parallel-relation to one another, on the underside of the outer portions of axles **325**,**330** (FIGS. **7** and **8**). Walking beams **340** are fastened to axles **325**,**330** by axle brackets **390** and **392**, respectively. A pivot-hole **394** is centrally located on each walking beam **340**, and is adapted to receive a pin or the like that couples each walking beam **340** to an outer end portion of lower pivot-plate **345**.

Referring to FIGS. **8** and **9**, lower pivot-plate **345** comprises a substantially rectangularly shaped piece of structural material, such as steel or the like, having a centrally disposed recess **397** defined therein. Upper pivot-plate **355** comprises a similarly shaped piece of structural material that is mounted over top of lower pivot-plate **345**. Upper pivot plate **355** comprises an annular ring disposed on its lower surface (not shown) that is sized and shaped so as to be slidingly received within recess **397** of lower pivot plate **345**. The upper surface of upper pivot plate **355** comprises a pair of spaced-apart upper pivot-brackets **410**. Each upper pivot-bracket **410** is adapted to be pivotally secured to a piston rod portion of a rail drive assembly lift cylinder **415**. The free end of each cylinder housing of each rail drive assembly lift cylinder **415** is pivotally fastened to a lower portion of vehicle frame **110**. Rail drive assembly lift cylinders **415** aid in the lifting of rail drive assembly **135** from engagement with rails **26** so as to switch from rail mode to road mode.

Advantageously, pivot plates **345** and **355** are secured to one another by pivot-bolt **405** so that lower pivot-plate **345** may be rotated clockwise or counterclockwise about pivot-bolt **405**, i.e., about a substantially vertical axis of rotation, in a range from about 5 to 10 degrees relative to the longitudinal axis of vehicle **100**. It will be understood from this construction that lower pivot-plate **345**, walking beams **340** and axles **325**,**330** may be pivoted about pivot bolt **405** and relative to upper pivot-plate **355**. Thus, the alignment of rail wheels **335** relative to rails **26** may be adjusted, prior to their engagement, so as to avoid improper engagement or misalignment of rail wheels **335** with rails **26**. Additionally, pivoting of lower pivot-plate **355**, and of rail wheels **335**, about pivot-bolt **405** allows vehicle **100** to traverse curves along the railroad track in a manner approaching that of a conventional rail car.

Torque-reaction plate **350** comprises an upper portion **351** and a lower portion **352**. Lower portion **352** is securely fastened to lower pivot-plate **345**, adjacent to recess **397**. Torque-reaction plate **350** projects upwardly in substantially perpendicular relation to lower pivot plate **345**. A pair of torque-reaction bars **425** are fastened between upper portion **351** and an upper portion of each axle housing **370**. In this way, when lower pivot-plate **345** is rotated relative to pivot-bolt **405**, the torque from this rotation is evenly applied to both axles **325**,**330** so as to minimize any shearing forces and to facilitate the pivotal movement of axles **325**,**330** about bolt **405**.

Referring to FIGS. **6** and **10**, a four bar linkage assembly **360** is disposed on the left and the right sides of vehicle frame **110** and comprises a pair of link members **435**,**436** and a pair of frame mount plates **440**. More particularly, link members **435**,**436** comprise elongate rods adapted to be pivotally mounted, at their ends, to portions of frame mount plates **440** and lift assembly support structure **365**. Frame mount plates **440** are fastened to vehicle frame **110** on the right and left sides thereof adjacent to, but forward of rail drive assembly **135**. A first end of each link member **435**,**436** is pivotally mounted to a portion of a frame mount plate **440** by means of a spherical sleeve bearing of the type that is well known in the art. A second end of each link member **435**,**436** is pivotally mounted to a portion of lift assembly support structure **365**.

Lift assembly support structure **365** comprises a pair of support stands **450** comprising a pair of vertically oriented support members **455**, an airbag-support plate **460**, back plates **465**, and a cross-brace **470**. More particularly, support stands **450** are disposed on the right and left outer end surfaces of upper pivot-plate **355** so as to position the lower edge of vertically oriented support members **455** on the upper surface of lower pivot plate **355**. In this way, airbag-support plate **460** is disposed in spaced-apart relation to lower pivot plate **355** and is structurally supported by vertically oriented support members **455**.

Each back plate **465** is positioned between the inner edges of vertically oriented support members **455** and the outer edges of central trunk portion **287** of support member **285**. An end of each of links **435**,**436** are pivotally fastened to a portion of a back plate **465** by spherical slip barrings of the type that are well known in the art. Cross-brace **470** is fastened to the inner surfaces of each back plate **465** so as to be transversely disposed between central trunk portions **287** of support members **285**. Cross-brace **470** provides structural stability to rail drive assembly **135**.

Referring once again to FIGS. **4** and **5**, road rail vehicle **100** is operated in a similar fashion as road rail vehicle **10**. More particularly, in the road mode the road wheels disposed on drive/steer axle **120** propel vehicle **100** independently of all of the rail wheels, i.e., unlike some prior designs, motive power directed to drive/steer axle **120** is not supplied via any of the rail wheels. This allows road rail vehicle **100** to travel at reasonable highway speeds and not to be limited to the low speeds associated with vehicles where road wheels are driven via rail wheels.

As with road rail vehicle **10**, road rail vehicle **100** comprises a selector **46** of known type for controlling the application of motive power to either drive/steer axle **120** or rail drive assembly **135**. Selector **46** may also incorporate controls for raising and lowering front rail guide assembly **130**, flip-up tag axle **125**, and rail drive assembly **135**, as desired, to switch between road mode and rail mode.

More particularly, vehicles **100** may be switched from road mode to rail mode by first positioning vehicle **100** over top the railroad tracks with the front end of the vehicle pointed in the direction of travel. In this position, first and second front rail engagement wheels **137**A and **137**B and rail wheels **335** of rail drive assembly **135** are positioned in substantially parallel spaced-relation to rails **26**, and flip-up tag axle **125** is in its lowered position (FIG. **4**).

The switch to rail mode is then begun by manipulating selector **46** so as to initiate the application of air, air/spring, hydraulic, or other known lifting/lowering mechanisms to lower front rail guide assembly **130** into engagement with rails **26** (FIG. **5**). Next, rail drive assembly **135** is lowered on to rails **26**. More particularly, airbags **295** are inflated and rail drive assembly lift cylinders **415** are actuated so as to allow rail drive assembly **135** to be slowly lowered onto rails **26**. It will be understood that rail drive assembly is guided in its downward travel by four bar linkage assembly **360**.

Advantageously, axles **325**,**330** of rail drive assembly **135** may be rotated relative to vehicle frame **110**, via rotation of lower pivot-plate **345**, so as to allow for proper alignment of rail wheels **335** on rails **26**.

Once rail drive assembly **135** has been lowered into engagement with rails **26**, flip-up tag axle **125** may be lifted up out of contact with the road surface. More particularly, flip-up tag axle **125** is first unlocked from vehicle frame **110** by removing a locking pin from locking holes **242**,**247** of lever-bracket **210** and pivot-bracket **215**. This releases flip-up tag axle **125** from locked engagement with vehicle frame **110**.

Next, actuation cylinders **275** are energized so as to pull upon lever-arms **227** of lever-brackets **210**. This causes frame **200** to pivot in a counterclockwise manner about the pivot pin disposed within frame-pivot hole **240** and pivot hole **245**. Once rod **305** is substantially withdrawn within cylinder housing **310**, flip-up tag axle **125** is fully disengaged with the road surface, as illustrated in FIG. **5**.

Advantageously, use of rear wheel drive in the rail mode, via rail drive assembly **135**, allows for better loading when shelf coupler **153** has a load of one or more freight or other rail cars coupled to it for pulling by vehicle **100**. More particularly, shelf coupler **153** may be powered vertically, through the inflation of airbags **295**, so as to engage a corresponding coupler on an adjacent rail car in order to transfer the load from the rail car to rail wheels **335** of rail drive assembly **135**. This operation generates a resultant downward force on rails **26** by rail wheels **335**, that allows for the application of sufficient tractive effort by rail wheels **335** on rails **26** for pulling/pushing heavy loads.

In order to return to the road mode, the foregoing procedure is simply reversed. More particularly, flip-up tag axle **125** is first pivoted clockwise about the pivot pin disposed within frame-pivot hole **240** and pivot hole **245** and then locked in place. Rail drive assembly **135** is then raised to the position shown in FIG. **4** by releasing the air from within airbags **295** and energizing lift cylinders **415**.

Although specific constructions have been presented herein, it is to be understood that these are for illustrative purposes only. Various modifications and adaptations will be apparent to those of skill in the art. In view of possible modifications, it will be appreciated that the scope of the present invention should be determined by reference to the claims appended hereto.

What is claimed is:

1. A road and rail vehicle comprising:

a vehicle frame having a front end, a rear end, a right side, and a left side and means for propelling said vehicle along a track, said propelling means mounted on said frame;

a first axle having a right road wheel and a left road wheel operably mounted thereon in spaced-apart relation to one another, said first axle being mounted on said vehicle frame adjacent to said front end;

a second axle having a right road wheel and a left road wheel operably mounted thereon in spaced-apart relation to one another, said second axle being mounted on said vehicle frame rearwardly of said first axle;

a third axle having a right road wheel and a left road wheel operably mounted thereon in spaced-apart relation to one another, said third axle being mounted to and supported upon said rear end of said vehicle frame by at least one pivotal bracket so as to be selectively movable into and out of engagement with a road surface;

a rail guide assembly including at least a right rail wheel and at least a left rail wheel operably disposed in spaced-apart relation to one another on a rail axle and adjacent to said front end of said vehicle frame wherein said rail wheel guide assembly is selectively movable into and out of engagement with the rails of a railroad track; and

a rail drive assembly including at least a right rail-drive wheel and at least a left rail-drive wheel operably mounted to an axle, wherein said axle is (i) operatively coupled to said propelling means, and (ii) movably mounted to said vehicle frame in confronting relation to said rail and between said second and said third axles, and further wherein said rail drive assembly include means for moving said axle relative to said frame so as to move said rail-drive wheels into and out of engagement with the rails of said railroad track.

2. The road and rail vehicle of claim **1** further comprising a mode controller operable to select between (i) a road mode in which said road wheels engage a road wherein said vehicle is propelled by driving said road wheels independent of said rail wheels, and (ii) a rail mode wherein said first rail wheel assembly and said rail-drive wheels engage the rails of said railroad track and further wherein said vehicle is propelled by driving said rail-drive wheels with all of said road wheels offset from engagement with any surface.

3. The road and rail vehicle of claim **2** comprising means for rotating at least a portion of said rail drive assembly about a vertical axis so as to provide for the adjustment of the orientation of said rail drive wheels relative to the rails of the railroad track when switching from said road mode to said rail mode.

4. The road and rail vehicle of claim **3** wherein said rail drive assembly comprises two axles operatively coupled together and each including a right and a left rail-drive wheel.

5. The road and rail vehicle of claim **2** further comprising a rail wheel unit movably supporting the right and left front rail engagement wheels for movement relative to the vehicle frame between an upper road position corresponding to said road mode and a lower rail position corresponding to said rail mode.

6. The road and rail vehicle of claim **2** wherein said means for propelling said vehicle comprise an engine supported by the vehicle frame and wherein said mode controller includes a transfer case and reversing transmission operable to selectively transfer power (i) from said engine to drive said right and left road wheels of said first axle when in said road mode; or (ii) from said engine to drive said right rail-drive wheel and said left rail-drive wheel of said rail drive assembly when in said rail mode.

7. The road and rail vehicle of claim **2** wherein said vehicle is driven by said first set of road wheels independent of said rail wheels when in said road mode.

8. The road and rail vehicle of claim **2** further comprising a first transmission adapted to transfer power from an engine to a transfer case and a second transmission adapted to selectively transfer power from said transfer case to said first axle when said vehicle is in said road mode and to said rail drive wheels when said vehicle is in said rail mode.

9. The road and rail vehicle of claim **2** comprising a shelf coupler disposed on said rear end of said vehicle and adapted to couple said vehicle to a corresponding coupler disposed on a rail car positioned on said railroad track wherein said shelf coupler comprises means for moving vertically relative to said corresponding coupler so as to engage said corresponding coupler and thereby transfer load from said rail car to said rail guide assembly so as to generate a resultant downward force on railroad track and thereby increase the tractive effort of said rail guide assembly for pulling/pushing heavy loads.

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